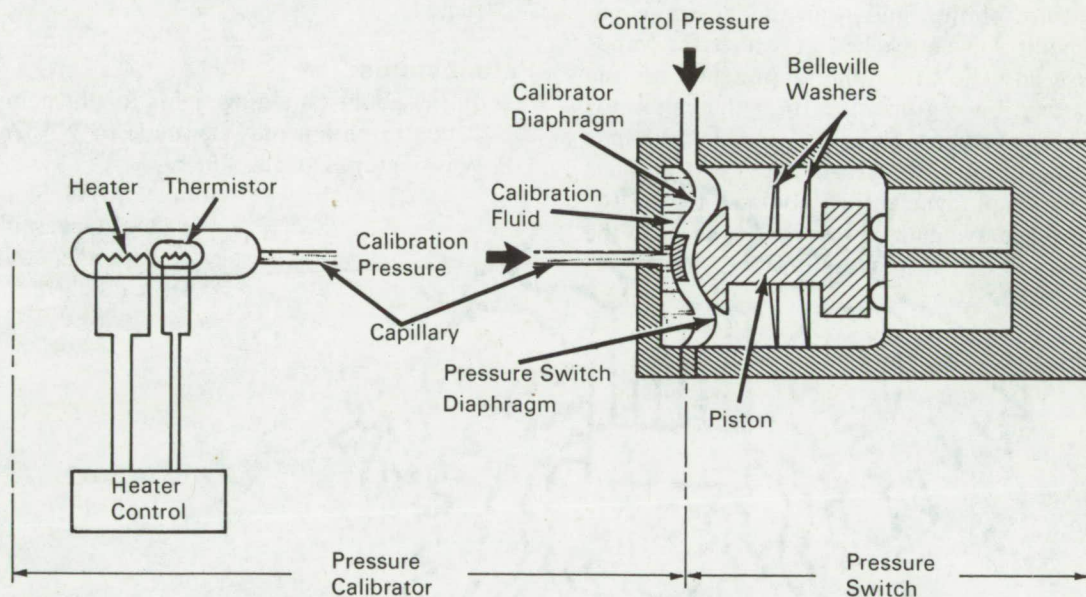


NASA TECH BRIEF



NASA Tech Briefs are issued to summarize specific innovations derived from the U.S. space program, to encourage their commercial application. Copies are available to the public at 15 cents each from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

Design Concept for Pressure Switch Calibrator



The problem:

In conventional pressure switches, fluid pressure acting on a summing diaphragm generates a force on a piston constrained by a pair of Belleville washers. As the pressure is increased, displacement of the piston may amount to several mils, while an additional displacement of several mils occurs abruptly during switching action (snap action of Belleville washers). In certain applications, pressure switches must operate within specifications under 150 g shock loads. Conventional pressure switches are not balanced for such loads, and therefore exhibit an acceleration sensitivity. To minimize this sensitivity, Belleville washers are designed to have a restraining force which is large compared to the unbalanced acceleration forces.

Typically, a force of 150 pounds must be applied to the piston, in order to actuate the switch. Precise in-place calibration of such a switch therefore requires a method by which a known or measurable force of up to 150 pounds can be generated and applied to the switch diaphragm (summing member) in such a way that the magnitude of the force is unchanged by the displacement of the diaphragm.

The solution:

A calibrator and switch design employing a saturated liquid-to-vapor phase transition at constant pressure to produce a known force (on a diaphragm of given area) independent of displacement over a usable range.

(continued overleaf)

How it's done:

As shown in the sketch, one end of a conventional pressure switch is modified by the addition of a diaphragm enclosing an appropriate calibration liquid which communicates with a controlled source of heat by means of a capillary. For the calibrator diaphragm configuration sketched, the calibration liquid is assumed to be cold, so that it is fully contracted. In this condition, any measured or control pressure greater than the vapor pressure of the liquid would not allow a calibrating force on the switch diaphragm. The spacing between the diaphragms would be chosen to allow for expected displacement of the fluid (liquid plus vapor) in the operating environment.

To conduct a calibration, the control pressure would be reduced to atmospheric pressure (by valving) and the heater control system would be actuated. As the temperature of the fluid near the heater is increased, a point will be reached at which the vapor pressure exceeds the atmospheric pressure on the liquid (plus any loading pressure from the calibrator diaphragm). The resultant force (the product of vapor pressure and calibrator diaphragm area) will displace the calibrator diaphragm until it contacts the switch diaphragm. When switching pressure is reached, the displacement of the switch diaphragm would not

affect the calibrating pressure, because it is essentially independent of the volume of the calibrating fluid. The fluid (vapor pressure vs temperature characteristics) and calibrator diaphragm area would be selected so that a calibrator unit of one design would be applicable to pressure switches used for a wide range of control pressures.

Notes:

1. A calibrator based on this concept would be most useful where the calibration could be carried out at a relatively slow rate so that saturated vapor conditions could be maintained in the region enclosing the heater and thermistor.
2. This device is in the conceptual stage only, and as of the date of publication of this Tech Brief, neither a model nor a prototype has been constructed.

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: M. G. Slingerland
of General Electric
under contract to
Headquarters, NASA
(Hq-36)